Chapter 6. Monitoring and Evaluation

Introduction

Monitoring and evaluation are separate and sequential activities required by National Forest Management Act regulations to determine how well the plan is working. Monitoring involves collecting data by observation or measurement. Evaluation involves analyzing and interpreting monitoring data.

The general purpose of monitoring is to detect changes or trends in a resource. Detection of a change or trend may trigger a management action, or it may generate a new line of inquiry. Monitoring data is most useful when the same methods are used to collect data at the same locations over time. It is important to note that cause and effect relationships usually cannot be demonstrated with monitoring data, but monitoring data might suggest a cause and effect relationship that can then be investigated with a research study.

Monitoring and evaluation activities provide ongoing feedback about management effectiveness and are essential elements of an adaptive management cycle that includes problem identification, solution, and implementation (figure 4). Monitoring and evaluation activities keep direction found in the plan up-to-date and relevant by being responsive to changing conditions and issues, including public desires, and to new information, such as research results or outcomes from management activities.

The monitoring and evaluation strategy (plan decisions) below is displayed in table 5. The information outside of this table are not plan decisions but are provided for background.

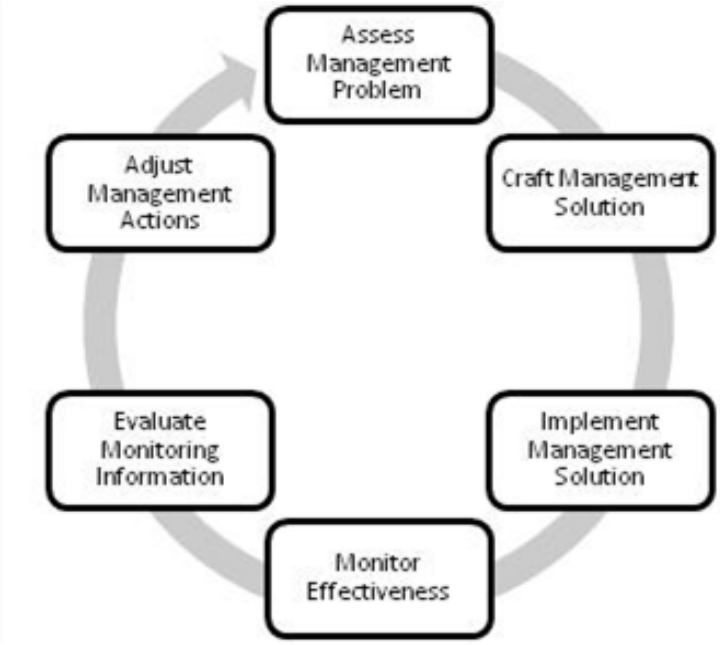

Figure 4. Elements of an "Adaptive" Management Cycle

Monitoring Strategy

A strategy for plan monitoring and evaluation has been designed to answer these three basic questions:

1. **Did we do what we said we were going to do?** The answers to this question should tell us how well the direction in the plan is being implemented. Collected information is compared to objectives, standards, guidelines, and management area direction.
2. **Did it work how we said it would?** The answers to this question should tell us whether the application of standards and guidelines is achieving objectives, and whether objectives are achieving or moving toward desired conditions.
3. **Is our understanding and science correct?** The answers to this question should tell us whether the assumptions and predicted effects used to formulate the desired conditions and objectives are valid.

The following guiding principles are key elements of the Prescott NF's monitoring strategy and serve as a framework for implementing an effective monitoring and evaluation program:

- Monitoring efforts are efficient, practical and affordable; take into consideration the best available science; and do not duplicate the collection of data already underway for other purposes.
- Monitoring tasks are scaled to the desired condition, objective, or management area direction to be monitored. Data that is collected for other purposes, but can also answer monitoring questions herein, are identified, compiled, and evaluated as part of the monitoring report.
- Monitoring considers effects of management on Forest Service lands and resources as well as adjacent lands and communities. Monitoring results from adjacent non-Forest Service lands are reviewed to identify how threats and resources may be crossing boundaries, and how pressures and management of surrounding lands may impact resources or activity on FS lands.
- Opportunities to complete monitoring and evaluation activities through partnerships and citizen collaboration are examined on a regular and ongoing basis.
- Monitoring is not performed on every single activity, nor does it need to meet the statistical rigor of formal research.
- A monitoring action plan is prepared initially and updated regularly. The monitoring action plan identifies and schedules various site specific, on-the-ground monitoring activities. It also describes the methods, locations, responsible persons, and estimated costs. Budgetary constraints may affect the level of monitoring that can be done in a particular fiscal year. If budget levels limit the Prescott NF's ability to perform all monitoring tasks, then those items specifically required by law are given the highest priority (e.g., items in table 5 under theme 1).
- A monitoring and evaluation report is prepared each year that summarizes the results of completed monitoring and evaluates the data for indicators of trends or effects.

- The forest supervisor annually evaluates the monitoring information displayed in the evaluation reports through a management review and determines if any changes are needed in management actions or the plan itself.
- The public is given timely, accurate information about plan implementation. This is done through the release of the annual monitoring and evaluation report.

The specific monitoring questions and performance measures that should be used to evaluate movement toward plan desired conditions under this monitoring strategy are displayed below in table 5 and arranged according to six monitoring themes:

4. Legally Required Monitoring
5. Conserving Biological Diversity
6. Retaining Ecosystem Resilience
7. Maintaining Watershed, Soil, and Air Quality
8. Sustaining Recreational and Social Benefits
9. Maintaining Infrastructure Capacity

In some cases, the monitoring question and performance measures directly assess accomplishment of desired conditions. In other cases, they gauge objectives or standards and guidelines associated with the desired conditions.

For each monitoring question/performance measure listed in table 5, additional monitoring descriptors are included to provide context for the type of information to gather and how often to gather it. These descriptors are defined here:

- **Frequency of Monitoring:** Describes how often information is gathered or measured such as annually, every 3 to 5 years, or every 10 years.
- **Frequency of Evaluation:** Defines how often the information is analyzed and reported. Depending upon the monitoring question, analysis of the information may occur at longer time intervals than the frequency of monitoring. For example, some resources need to be monitored annually to produce trend data but may be analyzed periodically (e.g., 3, 5 or 10-year cycle), depending upon the timeframe specified by each objective.
- **Data Precision and Accuracy:** Precision refers to how close the repeated measurements of the same quantity are to each other. Accuracy is a measure of how close a measurement is to the actual value of the variable being measured.

Two categories of reliability are appropriate at the plan scale:

- **Class A:** Methods generally are well accepted for modeling or quantitative measurement. Results have a high degree of repeatability, accuracy, and precision.
- **Class B:** Methods or measurements are based on project records, personal communications, ocular estimates, pace transects, informal visitor surveys, and similar types of assessments. The degree of repeatability, accuracy, and precision are not as high as class A methods, but they still provide valuable qualitative information.

Table 1. Monitoring Questions

Action, Effect, or Resource to be Measured	Monitoring Question	Performance Measure	Monitoring Frequency	Evaluation/ Reporting Frequency	Data Reliability
Theme 1 – Legally Required Monitoring (from the 1982 Planning Rule, Section 219)					
Comparison between estimated and actual plan objectives (Section 219.12(k)(1))	Are we achieving plan objectives within the estimated ranges?	Proportion of objectives accomplished	Annually	Annually	A
Plan objectives, standards, and guidelines (Section 219.12(k)(2))	Are the effects of forest management resulting in significant changes to the productivity of the land?	Changes in watershed condition class (6th level hydrologic units)	Annually	Every 5 years	A
Comparison of actual and estimated costs of activities estimated in plan objectives (Section 219.12(k)(3))	How close are projected costs with actual costs?	Dollars	Every 10 years	Every 10 years	A
Lands not suited for timber production (Section 219.12(k)5(ii))	Have areas classified as unsuited for timber production become suitable?	Amount of unsuited versus suitable acres	Every 10 years	Every 10 years	A
Maximum size of openings from even-aged management (Section 219.12(k)5(iii))	What percentage of openings created from even-aged management are 40 acres or less?	Percentage of harvest units	Every 5 years	Every 5 years	A
Destructive insects and disease [1] (Section 219.12(k)5(iv))	To what extent are undesirable outbreaks of insects and pathogens occurring within the plan area?	Acres of infestation and tree mortality	Annually	Annually	A
Population trends of the management indicator species [2] (MIS) in relation to habitat changes (Section 219.19(a)(6))	As a proxy for population, what are the trends in habitat for MIS within the plan area?	MIS habitat attributes; MIS occurrence and distribution	Annually	Every 5 years	A

Action, Effect, or Resource to be Measured	Monitoring Question	Performance Measure	Monitoring Frequency	Evaluation/ Reporting Frequency	Data Reliability
Theme 2 – Conserving Biological Diversity					
Vegetation diversity (Obj-1, Obj-2, Obj-3, Obj-4, Obj-5, Obj-6, DC-Veg-1)	What are the current condition and trend of key characteristics for vegetation identified in the desired conditions for the plan area?	Vegetation size class, percent canopy cover, and composition; carbon stored in vegetation; acres of treatment by treatment type.	Every 5 years	Every 5 years	A
	How effective are management actions at maintaining or making progress toward desired conditions for the key characteristics of vegetation within the plan area?				
Species diversity (Obj-1, Obj-2, Obj-3, Obj-4, Obj-5, Obj-6, Obj-25, Obj-26, Obj-27, Obj-28, DC-Ecosystem Resilience-1,DC-Wildlife-1 to 2)	To what extent are management activities providing ecological conditions to maintain habitat for viable populations of native and desired nonnative species?	Habitat acres treated; miles of fence modified; number of water developments improved; species surveys (e.g., fish, reptiles and amphibians, breeding birds, bats, etc.).	Every 1-5 years, depending on species	Every 5 years	A
Aquatic species (Obj-24, DC-Aquatic-1)	Are management actions maintaining or making progress toward desired habitat conditions for native fish, amphibian, and reptile species?	Aquatic habitat quality; stream miles improved.	Every 1-5 years, depending on species	Every 5 years	A
Federally listed species (DC-Ecosystem Resilience-1)	Have conservation actions or conservation strategies for federally listed species been implemented?	Number of plans or actions initiated.	Every 1-5 years, depending on species	Every 5 years	A
	What are the habitat trends for federally listed species on the Prescott NF?	Habitat attributes.			

Action, Effect, or Resource to be Measured	Monitoring Question	Performance Measure	Monitoring Frequency	Evaluation/ Reporting Frequency	Data Reliability
Theme 3 – Retaining Ecosystem Resilience					
Nonnative invasive plant species (Obj-6, DC-Veg-1)	What are the status and trend of areas infested by invasive plant species?	Acres of invasive species surveyed; acres of infestation treated.	Annually	Every 5 years	A
Fire (Obj-1, Obj-2, Obj-3, Obj-4, Obj-5, DC-Airshed-1, DC-Ecosystem Resilience-1)	Are management actions moving fire regimes toward desired conditions?	Acres treated by fire severity level and frequency.	Annually	Every 5 years	A
	To what extent is wildland fire used to maintain desired fuel levels and vegetation characteristics? To what extent is unwanted wildfire on the landscape suppressed?	Acres of fire managed for multiple objectives; acres of unwanted fire suppressed; postfire fuel loadings.			
	To what extent is prescribed fire used to maintain desired fuel levels, mirror natural processes, and/or restore desired vegetation characteristics?	Acres of prescribed fire by fuel type; postfire fuel loadings; vegetation species structure and density.			
	Has the risk for active crown fire been sufficiently reduced in fire-adapted ecosystems where crown fires were not frequent occurrences historically?	Predicted fire behavior by fuel type/loading.			
	To what extent are extreme weather patterns (e.g., precipitation and air temperature) affecting fire season length and severity?	Monthly/daily energy release component (ERC) estimates by fuel type.			

Action, Effect, or Resource to be Measured	Monitoring Question	Performance Measure	Monitoring Frequency	Evaluation/ Reporting Frequency	Data Reliability
Ecosystem resilience (DC-Ecosystem Resilience-1)	What management actions, measures, or decisions is the Forest Service taking to enhance ecosystem resilience or adaptation in response to changing environmental conditions?	Project level design features or mitigations.	Every 5 years	Every 5 years	A
Theme 4 – Maintaining Watershed, Soil, and Air Quality					
High priority watersheds (Obj-18)	Are management actions being implemented to improve watershed conditions?	Number of projects implemented.	Annually	Annually	A
Watershed features (Obj-19, Obj-23)	Are management actions being implemented to improve conditions of at-risk riparian areas, seeps, and springs?	Number of projects implemented.	Annually	Annually	A
Watersheds (Obj-20, Obj-21, Obj-22)	Are management actions being implemented to reduce negative impacts to watershed conditions?	Miles of repaired or improved roads, routes, or trails.	Annually	Annually	A
		Number of improved drainage crossings.	Annually	Annually	A
Airshed conditions (DC-Airshed-1)	Are management activities contributing or responding to air quality effects on human health or human enjoyment? Are air quality related values (e.g., visibility) of the Sycamore Canyon and Pine Mountain Wilderness areas being maintained?	Particulate matter ($PM_{2.5}$) recorded at smoke sensitive sites.	Annually	Annually	A
		Visibility using Interagency Monitoring of Protected Visual Environments (IMPROVE) program.	Annually	Every 5 years	A

Action, Effect, or Resource to be Measured	Monitoring Question	Performance Measure	Monitoring Frequency	Evaluation/ Reporting Frequency	Data Reliability
Theme 5 – Sustaining Recreational and Social Benefits					
Diverse recreation opportunities (Obj-7, Obj-8, Obj-10, Obj-13, Obj-14, Obj-16, DC-Rec-1, DC-Rec-Trails-2)	How many new recreation sites or locations have been added to the system? How many recreation sites or locations have been improved, relocated or decommissioned in response to known resource damage?	Number of facilities or sites, INFRA.	Annually	Every 5 years	A
	Does the number of recreation opportunities limit overcrowding, reduce user conflicts, and minimize resource damage? Does the range of recreation opportunities consider population demographic characteristics and desires of the local communities?	User satisfaction surveys (National Visitor Use Monitoring).	Every 5 years	Every 5 years	A
	To what extent are visitor information opportunities/ education activities being provided to the public?	Number and type of visitor information and education activities.	Annually	Annually	B
Eligibility for wild and scenic rivers (DC-Wild & Scenic-1)	Has there been adequate protection of outstandingly remarkable values (ORVs) of river segments that are eligible for wild and scenic river designation?	Changes to ORVs.	Every 5 years	Every 5 years	B

Action, Effect, or Resource to be Measured	Monitoring Question	Performance Measure	Monitoring Frequency	Evaluation/ Reporting Frequency	Data Reliability
Eligibility for wilderness designation (DC-Wilderness-1)	Has there been adequate protection of wilderness characteristics of areas that are eligible for wilderness designation?	Changes to wilderness character.	Every 5 years	Every 5 years	B
Land adjustment (DC-Open Space-1, DC-Lands-1, Obj-29)	To what extent is the Prescott NF land adjustment program supporting or enhancing plan desired conditions (open space, scenery values)?	Area of land adjustment that meets community open space needs and provides for natural resource values.	Every 5 years	Every 5 years	B
Theme 6 – Maintaining Infrastructure Capacity					
Roads, trails, and facilities (Obj-9, Obj-11, Obj-12, Obj-15, Obj-17) (DC-Rec-Trails-2, DC-Transportation & Facilities-1)	How many miles of the designated roads and trails are maintained to standard?	Miles of roads and trails.	Annually	Annually	A
	How many developed and designated recreation sites are being maintained?	Percentage of sites maintained.	Annually	Annually	A
	What proportion of trailheads and wilderness boundaries are adequately signed or marked?	Percentage of total trailheads; miles of wilderness boundary.	Annually	Every 5 years	A

[1] This item also meets the monitoring intent of theme 3, "Retaining Ecosystem Resilence."

[2] The list of 10 MIS found in the 1987 plan was reviewed and, based on recommendations from forest specialists, modified. The following three MIS were used to compare and evaluate the plan alternatives: pronghorn antelope, northern goshawk, and aquatic macroinvertebrate